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EDITORIAL

THE COLONIAL VETERINARY SERVICE

THE world has witnessed the rise and fall of many empires. These empires had much in common. They were born of force of arms and conquest, they were ruled and held by subjugation and exploitation, and they went to their decline and death on account of apathy at the centre and the cumulative resentment of the enthralled.

The British Empire differs profoundly from all its predecessors.

It was not founded by force of arms alone but in great measure by the initiative of individuals who, filled with courage and urged by the spirit of adventure, set forth to carve a career and found a home for their families overseas. These pioneer settlers were of the cream of our race; they went with peace in their hearts and in most cases they were received as friends. They did not seek to compel drastic changes in the way of life of their hosts; on the contrary, they accommodated their own ways to those of their new friends. They introduced the British code of honour and justice and brought an end to internecine hostility and strife, which had made life precarious in many lands both for animals and men.

They found that the natives followed an agrestic way of life based primarily on a wasteful pastoral economy of scouring the country in search of food without regard to the replenishment of the source, and with little thought for the future.

Nature's reaction and corrective was war and pestilence. It is fortunate that so potent a remedy was at hand to keep the animal and human population in

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ecological balance with supplies otherwise the world would have become one great Sahara.

Under the new ægis of law, order, and peace, the human and animal population increased, and although the previous drastic natural method of control had been salutary, such waste of life and resources could not be permitted to continue, for humane as well as economic reasons. It became obvious that steps must be taken to conserve and enhance both crops and animal husbandry so that a beneficent nature could be conserved and not despoiled. A well-ordered and prosperous agriculture is the basic factor in the progress forward of colonial economy, and its keystone is centred in an efficient Animal Husbandry.

To effect such an end disease must be conquered or brought under control, and this means work for many veterinary surgeons. Like all other callings, the veterinary profession had its pioneers, men of initiative and vision prepared to venture abroad and work for the future. We have ample evidence of the good work they did. Many diseases were investigated, overcome and brought under control. The animal population improved in stature and in numbers, and this in turn has made the opportunity and necessity for many more to follow in the steps of the pioneers.

The Colonial Veterinary Service, and also that of the Dominions, is under-staffed; they offer golden opportunity to those who want to do a worth-while job and appreciate a healthy, open-air life in which they can implement the teachings of the laboratory by large-scale biological trial in the field.

We are told that British graduates show little desire to apply themselves to the great task and the deficiencies have, on occasion, to be made up by the employment of aliens. Has the spirit which made Britain great departed from our shores? It will be a sad day if our young men forsake these golden opportunities either through default or apathy.

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GENERAL ARTICLES

THE EXMOOR PONY—AND A SURVEY OF THE EVOLUTION OF HORSES IN BRITAIN

By J. G. SPEED, M.R.C.V.S., and M. G. ETHERINGTON
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PART II*

The Celtic Pony

An examination of the material available to us suggests that in the next phase of their history our native horses became influenced by man's importation of foreign animals. By 250 B.C., or even earlier, the Celtic Pony of the Bronze and Iron Age settlers was common enough, but as a domestic animal only, and its remains are usually found in burials near human settlements. Just how this "Celtic Pony" was derived is difficult to prove. It had much of the earliest small Exmoor type pony in it, but that is not surprising since the Celtic settlers were likely to have come from, or at least to have traded along, the lands of its migration route, even before they came to Britain. In one instance a perfect, small, Arab-type stallion's mandible was found in a burial near one of these Celtic pony skeletons. It may be that this is an indication that the progenitors of the Arab horses, possibly the Iran-Nissi type, had been brought to Britain. This we consider significant and perhaps indicates that the Celtic Pony could have been produced in Britain by crossing the smaller original native pony with this early Arab prototype imported by the Celts, and which appears to have been a very slender animal of about 11 hands, as is shown by the bones from the Blewburton Excavation in the possession of the Reading Museum. Judging by the harness, the Celts did not ride their horses, but used them for light draught purposes.

These Celtic Ponies are not native or indigenous animals. Their modern representative, the Shetland Pony of to-day, appears to have a history which may be traced back to the Celtic settlers in Shetland, and that means over a period of perhaps 2,000 years. The amount of our native pony blood in the Shetland Pony is no doubt considerable and in some specimens is clearly dominant. Still, factors for variability are present in it, which are perhaps partly the result of this early experiment in cross-breeding by the Celts. As an example of the "Celtic Pony" there is the one which Professor Cossar Ewart brought from Iceland as a protoype, and of which the photograph is still used on the Continent of Europe to illustrate the typical Shetland Pony.

Unfortunately Professor Cossar Ewart did not record how it was bred, although he quickly recognised it as something quite characteristic. We have been lent its bones and skull by the Royal Scottish Museum and can quote a reference to it in an article on the Highland Pony by Thomas Dykes: "From the natural history point of view probably the most interesting pony at the Bungalow is the little mare which may well be described as an Arab in furs,

* Part I published in THE BRITISH VETERINARY JOURNAL, September, 1952.

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for beneath her tremendous coat of hair she has all the points of the Asiatic breed to which we are chiefly indebted for our modern racehorses."

Perhaps we can deduce from this how the "Celtic Pony" was derived. Shortly before the time of Professor Cossar Ewart's Penicuik experiments, something over 50 years ago, the Icelanders "improved" their ponies for riding, and Professor Cossar Ewart's "Celtic Pony" may well have been the result of crossing an Arab with one of the small Icelandic ponies which, to quote Gunnar Bjarnason, of Hvanneyri College, Iceland, in a paper delivered at Cologne, in February, 1951, are descended from the ponies of the Western Isles of Scotland, on which perhaps half of the Icelandic stock was founded about 870 A.D. In other words, the Celtic breeding experiments of the Bronze and Iron Ages may have been repeated in 1900 A.D.

We have a range of these Celtic pony skulls, ancient and modern, from Iceland, Shetland, the mainland of Scotland, England, and Java, all bearing very close relationship anatomically but varying in size, and therefore to be considered of cross-bred origin, since size is relatively constant in pure breeds of ponies.

Roman and Saxon Horses

The Roman invasion was the next stage in which we have found the impact of imported animals upon our native ponies. From the Signal Station Camp we have been lent a large number of bones by the Scarborough Museum, described as Roman and pre-Roman. These bones show a multiplicity of types, but with a tendency for the limb bones to become longer and more slender in the shaft than those of our prototype native ponies. There is an interesting comparison possible with the skulls, described by S. V. Afanasjev, which included some from the burial at Pazirik in the Altai Mountains. The comments in his work on the influence of the Scythian tribes' horse-breeding, and the suggestion that horses of the Ahal-Teke (Mongolian Arab) type already existed in the second century B.C. make interesting reading when we appreciate that the Scythian cavalry were so important in the Roman armies.

Afanasjev, in the paper mentioned above, to quote a German summary, made "a detailed study of skulls and skeletons of fossil horses, some dating back to the first century B.C., found in the Sajan-Altai District (Outer Mongolia) and also of *E. Prjevalski,* the Arab, and the Kirghiz horse. The conclusions are that some of the types of horses to-day exhibit similarity to horses that lived 2,500 years ago. It is thought that the Arab and Ahal-Teke breed have a common origin, namely the Persian-Nisean horse."

Grahame Clark makes reference to the Pazirik burials under the title "Scythian Tombs in the Altai," and quotes the dates of these burials as being some 2,000 years ago. The ten mares buried along with a chief or pastoral leader are described by him in the form of quotations from Professor Griaznov who carried out the excavations and recorded them in 1929.

Although the Romans had a very real admiration for the small, fiery, chariot horses of the Britons, and these were apparently "Celtic Ponies," or

even the Exmoor pony type, their own horses were a most heterogeneous collection; in some sculptures and friezes they are obviously our own small native ponies, and in other cases, long-limbed, round-cannoned, cross-bred horses. Probably their cavalry were frequently recruited locally and mounted on native ponies or horses, but it is evident that some of their animals were shipped to Britain and thus introduced foreign blood, which for our own convenience we refer to as Scythian.

This period of the Roman occupation certainly brought mongrel horse-blood to our country, and much of it was " Oriental," but the succeeding Saxon phase, judging by a few bones lent to us by the Southampton Museum, introduced a larger and heavier animal. Some of the Northern breeds of ponies and horses probably came to Britain at this time, but from the scarcity of material and the not very orderly habits of the Saxons, it is difficult to say whether these bones from Saxon middens, broken as they are for food, indicate any definite policy or system in their horse-breeding.

The Origins of the Heavy Horses

The horses of the Roman occupation may be dated from about the first century A.D. and those of the Saxons followed later, but the next important phase in the introduction of horses to Britain, or at least to its Northern and Western parts, occurred when the Scandinavian impact became evident. Although at some period early horses as well as other animals may have been able to walk dry-foot from Scandinavia to Scotland, as indicated by Judd, subsequent climatic changes are likely to have dealt hardly with these colonists in all but the Western fringe of Scotland and the South and West of England. It seems fairly evident that the Scandinavian Viking invaders of about the seventh century must have some of the credit for introducing our continental dun-coloured horses. Bones from a Viking burial on the Island of Colonsay, lent to us by the Royal Scottish Museum, are those of a strongly-built northern type of stallion. This we consider to be an important landmark in the history of our native horses, and probably a good pointer to the origin of the dun-coloured Highland garrons and the old type of Orkney or Shetland work pony (as opposed to the more popularly known little " Shetland pony ").

From then onwards confusion reigns as far as evidence of importation of definite breeds of horses is concerned, because with the increases in trade and travel numerous sources were opened up. The large breeds from the German Plains, evolved out of the local races of ponies, or the " diluvial horses," and selectively bred for size after judicious cross-breeding, and those from France of the Percheron progenitor type, no doubt greatly influenced our production of the heavy horses, and judging by their bones, as recently as 200 years ago they were splendidly strong animals and apparently healthy and long-lived, but obviously not so long-legged as many of those to-day. We have examined a number of skeletons of old-time Clydesdale horses, notably one from Dumbartonshire in the possession of the Hunterian Museum, and their strength and massiveness are remarkable.

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The Riding Horses

The lighter breeds present a much more confusing history, romance and something akin to misrepresentation being substituted for accurate record. It serves little purpose to discuss the possibility that a few imported stallions, themselves neither speedy nor noteworthy except from the fame of their produce in Britain, altered completely the quality of our horse population, converting it from the scrub beasts they were then assumed to be, into some of the finest stock in the world. Tracking down some of these romances has provided significant information; of the famous sires supposed to have founded our thoroughbreds, one, the Darley Arabian "covered very few mares except Mr. Darley's, who had very few well bred besides Almanzor's dam," to quote the General Studbook, but Galloway mares and "English" mares are, however, mentioned frequently enough, and in the words of the Polo and Riding Pony Studbook, it has been shown that "of the English mares which occur in the pedigree of famous racehorses many were ponies, in fact the most notable runners from pony and Galloway (13.2) races were taken up as brood mares into racing studs."

These ponies, the Galloway "running mares," it is fairly evident, had some quality recognised by breeders of the period. They have, however, been allowed to become extinct, like other once famous breeds of our native ponies such as, the Cushendal, the Long Mynd, the Manx, Tiree, Barra, and Goonhilly ponies.

Our own little prototype, the Exmoor, unintentionally traduced and misrepresented by its well-wishers even fairly recently, has, in a misguided attempt to explain its fleetness and high spirited qualities, been described as containing more of the Arab than our other breeds of ponies. It is faithfully described in this fashion by accepted authorities in European animal breeding, who in this error may have been led astray by our own British publications.

The story of how one of five stallions saved from the breaking-up of one of the primitive herds of Exmoor ponies found his way back over all obstacles to his own lair caused him to be romantically named Katerfelto after the fictional stallion of Whyte Melville's novel. The result of this adventure of a wild stallion has been that even friends of the Exmoor breed have claimed that the original Katerfelto ran with the wild herds and left his imprint on them. Our investigations into the history and anatomy of the Exmoor pony however, leave us in little doubt that it has less of Arab or other foreign blood than any pony or horse we have examined. This study has made us believe that in spite of the persistent importation of mongrel horses into Britain and the ill-advised attempts by well intentioned people to spread this "mongrelising" policy into practically all our breeding stocks, the hardships of our climate and geography, and the wise conservatism of some moorland farmers have succeeded in preserving for the world, ponies which can claim direct descent from the indigenous horse stocks. These ponies were the foundation of our famous breeds, and in a world of mongrels it is a relief to know that they are holding their own, however precariously, and that there is still available this small number of pure bred animals living like the red deer where earliest man hunted them so many years ago.

The Significance of our Native Ponies in Future Horse-Breeding Policy

That we have in Britain a race or races of ponies which resemble so closely our indigenous animals that we believe them to be their direct descendants may not appear to be important if we look upon the horse as a luxury animal. If, on the other hand, we take note of the tendency of agricultural policy in countries where subsidised agriculture is unknown and where an economical horse is demanded, then we may appreciate that the horse native to the country, and which can be demonstrated to have survived such difficulties as an Ice Age, should be considered likely to be at least constitutionally sound and economical. This economy of our native breeds of ponies is generally accepted, and we have found several anatomical reasons why they are healthy.

A study of their teeth has proved worth while and has explained much about their longevity and health. With the knowledge that a deep jaw provides implantation for large, strong teeth, one begins to look askance at a small head. We have had the jaws of representative specimen horses and ponies X-rayed and believe that the results provide some useful evidence of the importance of head conformation in breeding. The photographs of some of these X-rays are included in this sketch of the history of our native horses in the hope that without much detail of description they will show some of the significance of bone structure and tooth size.

It may be of interest to note that at the Pony Breeding Establishment at Isernhagen, near Hanover, this technique of distinguishing the breeding of horses by X-rays of teeth and joints is now being used by Herr Ebhardt in collaboration with the Veterinary College there, whilst as the result of 30 years' research work in line-breeding with Icelandic ponies, and some other selected breeds, including Hanoverian mares and Arab horses, in an attempt to establish which breed of horse is a basic foundation stock, and thus most suitable to be used for breeding economical work animals, his findings are startingly similar to those we are ourselves getting on the basis of our assumption that we have in Britain indigenous ponies which have evolved with the ecological succession of the last 100,000 years or more. We are indeed grateful to Herr Ebhardt for putting at our disposal the results of so many years' scientific research in horse breeding, and we are greatly impressed by the fact that our moorland farmers have saved for Britain the original wild stocks, which on the Continent of Europe have been " mongrelised " out of existence but their prototypes recognised again after 30 years' patient scientific research.

One of our conclusions is that we believe that intensive study will invariably point to a multiple origin for the horse. The only really serious original work done in Britain has been that by Professor Cossar Ewart about the beginning of the century, and a quotation from his findings, reproduced in the Transactions of the Highland and Agricultural Society of Scotland in 1904 we consider to be of supreme importance :—

" In the case of moor and mountain ponies the plan hitherto frequently followed has consisted in introducing Arab, thoroughbred, or other alien stallions, and leaving the rest to nature. The result of this method has either been the

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all but complete destruction of the native race it was sought to improve, or, at least at the outset, a decided loss of the vigour, hardiness, and other traits which adapted the indigenous race for its immediate surroundings.

" In some cases the breeder, in his desire to have increased size, more quality, or higher action, has rendered effective assistance in the process of extinction.

" Instances of this we have in the loss of the once famous Tiree ponies, and the even more famous Galloways of the South-West of Scotland. If all the horses have descended from the same wild progenitors, and if the difference between a cart-horse and high-caste Arab is mainly due to the differences in the environment, the improvement of the native breeds by the provision of Arab, hackney, and other sires, without any serious attempt at selection, may be regarded as in every way appropriate. But if, as is probable, horses, like dogs, have had a multiple origin—have sprung from several wild species evolved it may be, in widely separate areas—and more specially if in isolated and outlying areas fairly typical representatives of some of the remote wild ancestors still survive, it is conceivable that in future very different methods will be followed for improving the native races from those hitherto commonly adopted —that, e.g., it may be possible to improve the quality or add to the size and substance without the help of highly specialised artificial alien breeds devoid alike of the hardiness and the intelligence so essential for a semi-wild life."

We can only endorse this finding of Professor Cossar Ewart's and urge that all steps be taken urgently to preserve the fast-dwindling numbers of our pure native ponies. The wise policy of the sheep breeders of the past who knew the value of pure-breds from which to breed the desired crosses should be noted. Over-specialisation and show-ring selection tend to lead to degeneracy, or at least to a lack of economy, from which the only certain means of recovery is by the use of sound, native, foundation stock. To lose this pure stock would now be only too easy.

Specialised and improved breeds have been bred up from prototypes. A first and necessary step is to recognise and identify these prototypes. This is not merely a matter of historical interest, but is of vital importance to the veterinary surgeon and to the stockbreeder, in that only by this means is it possible to know the potentialities, good and bad, of our modern breeds. If by any fortunate chance the prototypes still survive, then every effort must be made to preserve sufficient of them in their original form so that reference may be made to them, and that further experiment may be carried out with them. This applies to all kinds of farm livestock, and the opportunity and the responsibility lie primarily with the veterinary profession.

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PLATE I

C.A.E.

FIG. 1

The Celtic pony which Professor Cossor Ewart brought from Iceland.

M.G.E.

FIG. 2

An Exmoor pony in winter coat. "These animals can claim direct descent from the indigenous horse stocks."

(*Article by Speed and Etherington, page* 315)

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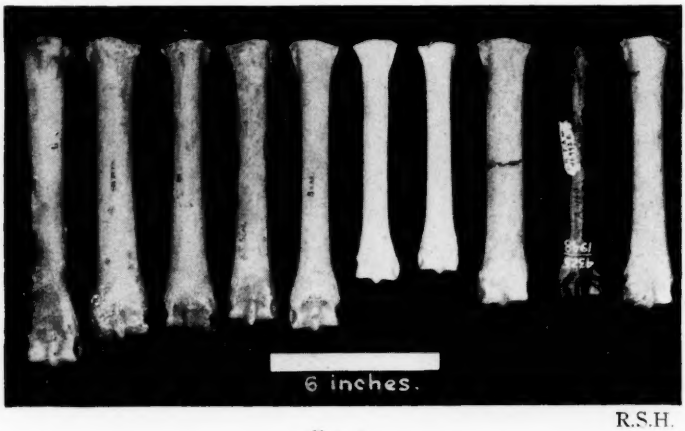
D.P.

FIG. 3
A Roman mercenary mounted on a small native pony.

D.P.

FIG. 4
A Roman legionary on a cross-bred.



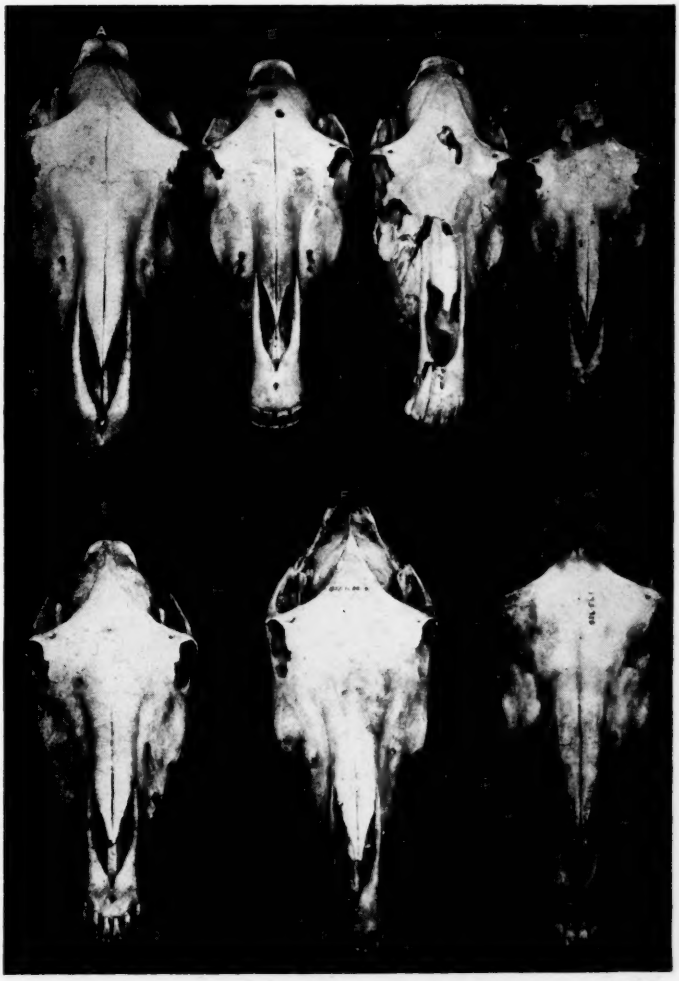
R.S.H.

FIG. 5
A range of metatarsals to illustrate some modifications produced by cross-breeding.

(*a*) A modern Arab.
(*b*, *c*, *d*, and *e*) Roman cross-bred horses.
(*f*) Modern Shetland-type pony.
(*g*) The Iron Age Celtic pony.
(*h*) Fossil pony from Sussex Chalk Conglomerate.
(*i*) Fossil pony from Alaskan Pleistocene gravels.
(*j*) Young Exmoor mare.

(*Article by Speed and Etherington, page* 315)

PLATE III



R.S.H.

FIG. 6

A range of skulls to illustrate the relationship of the Celtic ponies to the native pony and to the Arab. "All bearing very close relationship anatomically, but varying in size."

(*a*) The smaller northern Pleistocene pony (Exmoor).
(*b*) Shetland-type pony.
(*c*) Iron Age Celtic pony, 250 B.C.
(*d*) Java pony.
(*e*) Professor Cossor Ewart's "Celtic" pony from Iceland.
(*f*) Modern English-bred Arab mare.
(*g*) Desert-bred Arab stallion.

(*Article by Speed and Etherington, page* 315)

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OBSERVATIONS ON THE VITAMIN C STATUS AND HÆMATOLOGY OF BRACKEN-FED RUMINANTS

By F. E. MOON* and J. M. McKEAND

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In earlier work on experimental bracken "poisoning" in sheep (Moon and Raafat, 1951) post-mortem tissue analyses showed relatively low concentrations of vitamin C in liver, kidney, heart and adrenals. Further tests have been made with one bullock and two sheep, fed largely on bracken. The bullock, which was fed on a mixture of hay and artificially dried bracken, developed bracken "poisoning" and died after 44 days but the sheep, which were fed almost entirely on dried bracken for most of the experiment, survived for 125 days in one case (sheep H) and 289 days in the other (sheep K). Vitamin C was given subcutaneously to sheep K at regular intervals during a period of 57 days and this sheep did not develop bracken "poisoning" until a further 153 days after vitamin treatment was discontinued. There is, however, no evidence that the longer period of survival of this sheep was connected with the vitamin C administration.

Urinary Excretion of Vitamin C

Average values for the urinary excretion of vitamin C, determined by the method of Roe and Kuether (1943), are shown in Table 1. In the case of

TABLE 1

Urinary Excretion of Vitamin C (mg./day)

Animal	Pre-experimental period (10 days)	Experimental periods (10 days each) 1	2	3	4	5	6	8	10	12
Bullock ...	117	30	97	74	105	44*	—	—	—	—
Sheep H ...	18	16	8	10	13	16	9	9	11	9
Sheep K ...	9	9	9	9	6	5	10	14†	14†	12†

* Average for last four days before death from bracken "poisoning."
† Values obtained during periods of treatment with vitamin C.

the bullock there was a marked fall at the commencement of bracken feeding, and this is attributed to the very low food consumption at that time. When the amount of food eaten increased there was a corresponding rise in vitamin C excretion, and this did not show any further marked decline until the animal went off its food at the end of the experiment, when bracken "poisoning" developed. The excretion of vitamin C by sheep H was higher during the pre-experimental period (when hay alone was fed) than during bracken feeding, but the value during period 12 (five days before death from bracken "poisoning") was similar to some figures obtained shortly after the commencement of bracken feeding. During the pre-experimental feeding, sheep K excreted less vitamin C than sheep H, but there was no decline when bracken was fed; during the periods of vitamin administration there was an increased urinary excretion. Since the results obtained with the bullock and sheep H did not suggest any

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gradual depletion of vitamin C, the regular analysis of the urine of sheep K was discontinued some time before bracken "poisoning" developed in this animal.

Plasma Vitamin C

In Table 2 are shown the concentrations of vitamin C in the blood plasma of the experimental animals. The last sample from the bullock, showing a vitamin C content of 5.3 mg./litre, was taken on March 20; the animal's temperature at that time was still normal, but rose to 107° F. four days later and death ensued on March 26. On the basis of these figures there is no deficiency of vitamin C in bracken "poisoning" unless the deficiency develops rapidly in the terminal stages when the symptoms appear. The plasma of sheep H did show a fairly regular decline in vitamin C content during the later periods of bracken feeding, but no value comparable with those of human plasma in vitamin C deficiency was obtained. On October 18, four days before death from bracken "poisoning," this sheep was already showing an elevated temperature (105.2° F.) and the plasma vitamin C had fallen to 3.0 mg./litre. Although 300 mg. of vitamin C were given subcutaneously on each of the following three days, and the plasma vitamin C level increased to 8.3 mg./litre on October 22, death from bracken "poisoning" was not prevented. Sheep K maintained a high plasma vitamin C level throughout the experiment, irrespective of whether or not vitamin C was administered. At the end of experimental period 28 (March 25) the concentration was 9.2 mg./litre, and on April 1 it was still comparatively high (6.0 mg./litre). Subcutaneous administration of 300 mg. vitamin C on April 3 and again on April 4 did not prevent the death of this animal from bracken "poisoning" on the latter date.

TABLE 2

Plasma Vitamin C (mg./litre)

Animal	Pre-experimental period	Experimental periods 1	2	3	4	6	8	10	12	16	20	24	28
Bullock ...	5.6	4.1	4.7	4.4	5.3	—	—	—	—	—	—	—	—
Sheep H ...	7.9	7.4	6.9	10.3	10.0	9.5	6.9	5.6	3.3	—	—	—	—
Sheep K ...	8.0	8.2	8.1	5.8	7.3	7.3	7.3*	8.4*	6.7*	7.4*	7.7	7.2	9.2

*Values obtained during period of treatment with vitamin C.

Saturation Tests

The vitamin C therapy applied to sheep H and K when bracken "poisoning" became evident was without effect on the development of the condition, but the figures for urinary excretion of the vitamin, following subcutaneous administration, are of interest and are shown in Fig. 1. Sheep H was given 300 mg. of the vitamin on each of three successive days, but it was only after the third dose that there was any appreciable excretion; this may be interpreted as evidence of vitamin C deficiency. Typical results for a normal animal given similar vitamin treatment are shown in the graphs for sheep N; on each day considerably more than half the test dose was excreted in 24 hours and although the excretion on the third day was less than on the second, this may be the result of an increased rate of destruction following repeated intakes of relatively

large amounts of vitamin, as suggested by Sigurjonsson (1951). Sheep K was tested in the same way in January, 1952, whilst being bracken-fed but long before any symptoms of bracken "poisoning" were evident; although the excretion of administered vitamin was less than in the case of sheep N, the results obtained appeared to be normal. When the marked anæmia of bracken

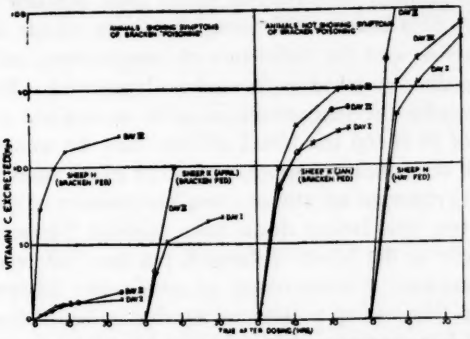
ANIMALS SHOWING SYMPTOMS OF BRACKEN POISONING
ANIMALS NOT SHOWING SYMPTOMS OF BRACKEN POISONING
VITAMIN C EXCRETED(mg.)
SHEEP H (BRACKEN FED)
SHEEP K (APRIL) (BRACKEN FED)
SHEEP K (JAN.) (BRACKEN FED)
SHEEP N (HAY FED)
DAY 1
DAY 2
TIME AFTER DOSING (HRS.)

FIG. 1.—EXCRETION OF VITAMIN C FOLLOWING DAILY SUBCUTANEOUS DOSES OF 300 mg.

"poisoning" became evident in April, 1952, sheep K was again treated with the vitamin but died before three successive daily injections could be given. Nevertheless the excretion shown in Fig. 1 for the first day was considerably greater than was obtained from sheep H, and on the second day the slope of the curve up to the time of death was comparable with the slope of the normal excretion curves. Thus there was no evidence of acute vitamin C deficiency in sheep K, even in the terminal stages of bracken "poisoning."

Tissue Vitamin C

The tissue vitamin C figures recorded in Table 3 include the diketogulonic acid as well as the ascorbic and dehydroascorbic acids present. Although the two sheep had received vitamin treatment immediately before death, their

TABLE 3

Total Vitamin C in Post-mortem Tissue Samples (μg./g.)

Animal			Liver	Kidney	Heart	Adrenal	Small-intestine
Bullock	...	...	162	149	76	784	110
Sheep H	...	...	184	149	45	960	195
Sheep K	...	...	329	129	71	763	238

tissues did not show any evidence of this, the values for all three animals being somewhat low.

From the results obtained in these experiments it seems clear that the hæmorrhagic syndrome of ruminant bracken "poisoning" is not due to a simple deficiency of vitamin C, although there are indications that in the terminal stages of the disease there may be an increased destruction of this vitamin in the tissues.

Hæmatology

The occurrence of leucopenia in cattle suffering from bracken "poisoning" has been reported by Naftalin and Cushnie (1951) and by Evans, Evans and

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Hughes (1951). This was confirmed for sheep in the present experiments, the blood of sheep H two days before death having only 225 leucocytes per c.mm. More extensive hæmatological data were obtained for sheep K, using the methods described by Holman (1944), and are given in Table 4. With this animal the leucopenia was evident when the first blood sample was examined after 132 days of feeding on dried bracken; nevertheless, death from bracken " poisoning " did not occur until 157 days later. Differential leucocyte counts did not show any very marked variations and the deficiency of lymphocytes and monocytes was just as marked as that of polymorphonuclear leucocytes. Evans, Evans and Hughes (1951) describe the leucopenia in cattle as mainly a reflection of an agranulocytosis, but in sheep the blood picture may be somewhat different as the development of the condition appears to occur much more slowly. Naftalin and Cushnie (1951) reported an almost complete absence of granulocytes in the blood of heifers a few days before death from bracken " poisoning," but 30 per cent of the leucocytes in the blood of sheep K ten days before death were found to be polymorphonuclear. Unfortunately no satisfactory differential counts were obtained later than this, owing to the very small number of leucocytes found in the films prepared from peripheral blood.

The thrombocytopenia associated with bracken " poisoning " in cattle may also occur in sheep, although the difficulties in counting platelets are well known and the variations in the numbers occurring in healthy blood are quite enormous, Holman (1944) giving the range for sheep as 50,000 to 550,000 per c.mm. Values below 50,000 per c.mm. were obtained with sheep K in December and early January, but the numbers subsequently increased and did not again fall below 50,000 until the last sample, taken the day before death. The development of the disease in sheep K was much more clearly marked by the progressive fall in erythrocyte count and hæmoglobin concentration than by any changes in platelets or leucocytes. In cattle, Evans, Evans and Hughes (1951) claim that red cell counts are normal except in the terminal, post-hæmorrhagic stages. With sheep K, however, the red cell count on October 29, 157 days before death, was only 9,100,000, the normal range (Holman, 1944) being 9,700,000 to 13,300,000. There were considerable fluctuations in this count subsequently but the figures were mostly below 9,500,000 and during the last 70 days there was a marked and fairly regular decline, roughly paralleled by the falling hæmoglobin concentration. These results might be taken to indicate progressive hæmorrhage occurring long before the development of obvious symptoms of bracken " poisoning," but apart from the clinical symptoms of anæmia sheep K showed no signs of hæmorrhage until the elevated temperature of bracken " poisoning " developed. Some blood was seen only in the terminal fæces on the day of death and although post-mortem examination showed the usual hæmorrhages on the walls of the abomasum and small-intestine, there were no voluminous blood clots. It seems likely, therefore, that in bracken-fed sheep the decline in red cells and hæmoglobin occurs before the development of widespread hæmorrhages and may be the result of the ability of sheep to withstand bracken feeding for prolonged periods. As the life-cycle of the red cell is very

TABLE 4

Hæmatological Data (Sheep K)

Date	Days of bracken feeding	Red blood cells (x10⁶/c.mm.)	Hæmoglobin (g./100ml.)	Platelets (x10³/c.mm.)	White blood cells (/c.mm.)	Granulocytes (/c.mm.)			Agranulocytes (/c.mm.)		
						Basophils	Neutrophils	Eosinophils	Large lymphocytes	Small lymphocytes	Monocytes
Oct. 29	132	9.1	9.3	—	1,800	—	—	—	—	—	—
Nov. 5	139	9.1	8.7	—	3,700	—	—	—	—	—	—
Nov. 12	146	9.8	7.7	120	1,000	40 (4%)	350 (35%)	20 (2%)	50 (5%)	520 (52%)	20 (2%)
Nov. 19	153	8.7	10.4	54	450	0	135 (30%)	9 (2%)	198 (44%)	90 (20%)	18 (4%)
Nov. 29	163	8.1	7.9	320	1,800	—	—	—	—	—	—
Dec. 3	167	7.3	7.6	259	900	0	360 (40%)	0	126 (14%)	405 (45%)	9 (1%)
Dec. 9	173	9.5	6.3	209	1,200	12 (1%)	456 (38%)	24 (2%)	216 (18%)	456 (38%)	36 (3%)
Dec. 17	181	9.7	8.0	29	1,400	0	448 (32%)	0	224 (16%)	672 (48%)	56 (4%)
Dec. 21	185	8.6	6.9	45	1,400	14 (1%)	336 (24%)	28 (2%)	350 (25%)	644 (46%)	28 (2%)
Dec. 28	192	7.5	7.4	44	1,600	0	464 (29%)	0	288 (18%)	832 (52%)	16 (1%)
Jan. 2	197	7.2	7.2	38	600	0	168 (28%)	0	114 (19%)	306 (51%)	12 (2%)
Jan. 7	201	7.4	7.4	57	1,100	0	385 (35%)	0	44 (4%)	649 (59%)	22 (2%)
Jan. 14	208	10.1	7.7	190	975	0	351 (36%)	0	146 (15%)	468 (48%)	10 (1%)
Jan. 21	215	11.4	7.0	350	950	10 (1%)	209 (22%)	10 (1%)	123 (13%)	569 (60%)	29 (3%)
Jan. 29	223	7.4	7.4	183	1,020	10 (1%)	235 (23%)	0	184 (18%)	581 (57%)	10 (1%)
Feb. 4	229	6.6	6.3	127	1,140	11 (1%)	262 (23%)	11 (1%)	114 (10%)	730 (64%)	12 (1%)
Feb. 11	236	6.0	6.6	112	1,470	29 (2%)	324 (22%)	0	235 (16%)	867 (59%)	15 (1%)
Feb. 18	243	5.8	6.4	93	1,000	0	300 (30%)	0	220 (22%)	470 (47%)	10 (1%)
Feb. 25	250	6.4	6.0	82	1,430	0	315 (22%)	0	229 (16%)	858 (60%)	28 (2%)
Mar. 7	261	5.5	5.6	55	1,310	0	341 (26%)	0	262 (20%)	681 (52%)	26 (2%)
Mar. 17	271	5.1	6.6	55	1,290	0	322 (25%)	0	194 (15%)	774 (60%)	0
Mar. 25	279	4.4	4.9	63	1,100	0	319 (29%)	11 (1%)	132 (12%)	627 (57%)	11 (1%)
Apr. 1	286	3.8	4.0	53	1,200	—	—	—	—	—	—
Apr. 3	288	2.5	2.9	44	1,500	—	—	—	—	—	—

long compared with that of the white cell, changes in the bone marrow interfering with blood cell formation would be rapidly reflected in the numbers of circulating leucocytes (particularly the granulocytes) but could only affect the numbers of red cells in the circulation after a much longer period. Cattle do not appear to survive long enough for this change in red cell count to occur, except as a result of the terminal hæmorrhage, whereas sheep, for some as yet unexplained reason, can survive bracken feeding for much longer periods and thus show a somewhat different blood picture.

Summary

In the terminal stages of bracken "poisoning" in ruminants there may be an increased destruction of vitamin C, but there is no evidence of a simple deficiency of this vitamin resulting from bracken feeding.

The occurrence of leucopenia, previously reported in cattle suffering from bracken "poisoning," has been confirmed for sheep. There was also some indication of a deficiency of platelets in the terminal stages, but the development of bracken "poisoning" in an experimental sheep was more clearly marked by a progressive fall in erythrocytes and hæmoglobin. Differences from the blood picture in bracken-fed cattle may be due to the ability of sheep to tolerate bracken feeding for much longer periods.

Acknowledgments

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THE EFFECT OF PREGNANCY AND PARTURITION ON THE TUBERCULIN SKIN SENSITIVITY OF THE SOW

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Loss of skin sensitivity during the course of a tuberculous infection has important implications. This is especially so where eradication of tuberculosis, either from a herd or an area, is being carried out by means of the intradermal tuberculin test, the interpretation of which depends on the presence or absence of a state of skin sensitivity. Factors which provoke alterations in this sensitivity of the skin are therefore of practical importance.

Kerr, McGirr and Robertson (1949), in a study of the specific and non-specific desensitisation of the skin of cattle sensitised to *Trichomonas fœtus* infection, found that with specific desensitisation there was a temporary depression in the number of lymphocytes and an increase in the number of neutrophils. At the same time the skin reaction to the appropriate antigen was greatly reduced and in some cases it disappeared entirely. These authors further showed that at parturition desensitisation of the skin occurred and also there was an absolute reduction in the lymphocytes immediately after calving. In addition it was shown that such substances as sphingomyelin and adrenal cortical sterones produced the same blood changes in cattle, viz., a lymphopenia and an increase in neutrophils. In 1946, Kerr, Lamont and McGirr reported that of twenty cows giving a positive reaction to tuberculin *ante partum* seven did not react at all, five would have been regarded as non-specific on the basis of the comparative test interpretation, and the remaining eight all showed a marked drop in skin sensitivity when tested 1 to 14 days after parturition. In addition there was a drop in the number of lymphocytes and a rise in the neutrophils at calving. Wade (1942), using rabbits, also noted a transient decrease in the intensity of the skin reaction after parturition.

A number of pertinent observations have been carried out in human beings. Bar (1923) found the tuberculin test negative or weakly positive in many cases in pregnancy. Nobecourt and Paraf (1927) claimed that the tuberculin test was negative in 15 to 20 per cent of women during pregnancy. Stern (1910) reported on the results of a survey of the tuberculin test on groups of pregnant and non-pregnant women. In the pregnant group 30 per cent reacted, while in the non-pregnant group 65 per cent gave a positive reaction. A similar survey was made by Bar and Devraigne in 1911 and a much smaller difference was found by these authors between the positive reactors in the pregnant and non-pregnant groups: 9 per cent as compared with 35 per cent as found by Stern. On the other hand, Conn (1942) found that 38 out of 41 women retained their sensitivity throughout pregnancy. Lichtenstein (1942) also investigated the status of the tuberculin test during pregnancy. His data indicated that in no instance was a pregnant tuberculous patient insensitive to tuberculin, but he found that in about 25 per cent of the 82 patients studied a depression in sen-

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sitivity occurred towards the end of pregnancy. The level of sensitivity returned to normal shortly after parturition.

In the present investigation a group of eight sows was tested during pregnancy and before and after parturition. The group contained two sows infected with tuberculosis of bovine type, five sows with an avian type infection, and one had a dual sensitivity.

Sow C was a reactor and brought to the laboratory 30 days before farrowing; she was tested with Weybridge retest tuberculin in the field, and gave a very large reaction. On arrival at the laboratory she was tested with 1 to 1,000 dilution of the above tuberculin and the skin reaction measured 5 mm. and had an intensive purple coloured centre. At this test there was an increase at the site of the previous test up to 20 mm. When farrowing started the sow was tested again with the dilute tuberculin and showed a rise of only 2 mm. in skin thickness. Three weeks after farrowing she was tested with the dilute tuberculin and a skin reaction of 8 mm. was recorded. Ten weeks later the dilute tuberculin evoked a reaction of 5 mm.

Sow X 50.—This was an acquired mammalian type infection; 14 days before farrowing the skin reaction with retest tuberculin was 22 mm. At parturition the reaction measured 10 mm. and 15 days later the skin response was 19 mm.

Sow X 51.—This sow had been infected experimentally with both avian and bovine type cultures. When tested just after service with avian retest tuberculin the skin reaction was 12 mm. A bovine type infection was induced three months before farrowing. She was tested seven weeks before parturition with avian and mammalian tuberculins at separate sites. The avian reaction was 17 mm. and a very large intense reaction (estimated to be 55 mm.) developed at the mammalian test site and an adequate measurement could not be obtained by the usual calipers. A further test was carried out at parturition and the mammalian reaction was again very large and measured 43 mm.; the avian site gave a reaction of 14 mm. Three weeks after farrowing she was again tested and the mammalian reaction was 45 mm. and the avian response was 30 mm.

Sow Z 56.—This sow had been reared at the laboratory and had been satisfactorily sensitised at eight weeks of age with the intraperitoneal administration of avian type culture. Prior to service the skin sensitivity was reinforced by the subcutaneous injection of 1 ml. of an avian lesion emulsion. She was tested 24 days before farrowing and gave a skin reaction of 29.5 mm. A further test was made at the time of farrowing and a reaction of 18.5 mm. was evoked; 11 days after farrowing a further test gave a skin reaction of 31.5 mm.

Sow Z 58.—This sow had the same pre-service history as No. Z 56. At a test 48 days before farrowing the skin increase was 28 mm. At farrowing the skin reaction was 33.5 mm. This sow was tested six days later at a time when skin erysipelas was developing and a very large swelling appeared within 24 hours of the injection of the tuberculin. This swelling involved most of the ear lobe and was unmeasurable with the ordinary calipers; it disappeared at a much faster rate than is typical of the usual tuberculin reaction. A further test made eight weeks after farrowing induced a skin reaction of 33 mm.

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Sow Z 56 was observed during a second pregnancy. Three weeks after service a skin reaction of 33 mm. was recorded. Ten days prior to farrowing the skin reaction was 20 mm. At farrowing a skin response of 43 mm. was evoked and 12 days after farrowing the skin reaction was 17 mm.

Sow Z 58 was also under observation during a second pregnancy. Eight weeks prior to parturition the skin reaction was 16 mm. She was tested 24 hours after farrowing and a skin response of 8.5 mm. was elicited. A further test eight weeks later gave a skin reaction of 21.5 mm.

Sow Z 60.—This sow was an experimental avian infection. Tested ten days after service a skin increase of 27 mm. was recorded. At farrowing the skin reaction was 28 mm.

Within this small group there is considerable variation in the behaviour of the skin sensitivity at parturition. Both of the mammalian sensitivities showed a measure of densitisation. The drop in skin sensitivity in the case of sow C was from 5 to 2 mm., but in view of the dilute tuberculin used this is regarded as evidence of desensitisation. In the case of sow X 50 the desensitisation was quite evident and the skin reaction dropped from 22 to 10 mm. The behaviour of sow X 51 is interesting on account of the high degree of sensitivity shown to the mammalian tuberculin. In this case a mammalian sensitivity was superimposed on an existing avian infection. However, in experiments at this laboratory there was no evidence that a mammalian infection following an existing avian one had any enhancing effect on either sensitivity. The behaviour of the avian reaction in this sow did show some variation compared with the behaviour of the mammalian reaction. In view of the abnormally high sensitivity obtained in this animal, it would be unwise to draw definite conclusions from this testing history. It should be noted, too, that reactions over 40 mm. are difficult to compare on the basis of measurement alone. Such large reactions usually involve most of the ear lobe and the swelling may extend beyond the base of the ear itself. In such cases, therefore, the accurate measurement of the conventional fold of the skin at the reaction site is well nigh impossible.

In the avian sensitised group only two out of five sows showed a depression of sensitivity at parturition. In the case of Z 56 a drop in the skin reaction of 11 mm. was recorded and at the second farrowing of Z 58 there was a depression in the skin reaction amounting to 7.5 mm. Of the other avian sensitised sows one showed no alteration in sensitivity and in the other two there was some enhancement in the reaction at parturition as compared with the reaction before and after the termination of pregnancy. In one case the concurrent development of swine erysipelas may have interfered with the normal development of the reaction. It is interesting to note that a sow may show a depression in sensitivity at one parturition and an enhancement of the reaction at a second farrowing. In the series of cows reported on by Kerr *et alia* (1946) three animals showing an avian sensitivity were scarcely affected by parturition.

With regard to the possible effects of pregnancy itself on sensitivity, sufficient data are not available to make any definite pronouncement. If the skin reactions after the termination of pregnancy are compared with those

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during gestation, then in two cases only were the reactions during gestation less than those after parturition. In sow C the test during pregnancy was 5 mm. and that after pregnancy was 8 mm. However, in view of the dilute tuberculin used this small difference may be significant. In the case of Z 58 an avian tuberculin test eight weeks before parturition gave a skin reaction of 16 mm. Eight weeks after parturition the reaction was 21.5 mm. In the light of the tendency for avian sensitivities in general to wane and the fact that sixteen weeks intervened between the two tests, the lower reaction may indicate some loss of sensitivity during gestation.

Summary

A group of eight sows were tested with tuberculin during pregnancy and before and after parturition. Two of these were sensitised to bovine type and five to avian type of tuberculosis and one had a dual sensitivity. In both the bovine-sensitised sows there was evidence of some desensitisation. Two out of five avian-sensitised sows showed some desensitisation at the time of farrowing and in two of the avian-infected sows there was an enhancement of the reaction at parturition.

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THE THERAPEUTIC AND PROPHYLACTIC PROPERTIES OF ANTRYCIDE IN TRYPANOSOMIASIS OF CATTLE

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PART II

Mariakani Experiments

I. Description of Site and Cattle

The coastal forests of East Africa from North Kenya to Zululand are infested with *Glossina austeni*. This species is confined to its forest habitat and never emerges more than a few yards into open country. Opinions differ about its danger to stock. In South Africa, its importance is to a certain extent discounted since it is believed that trypanosomiasis transmitted by it is less deadly than that transmitted by other tsetses. Silva (1951) considers it to be a source of danger in Portuguese East Africa and that it may cause heavy losses. Results with control cattle at Mariakani confirm Silva's view.

In the hinterland of Mombasa, forest has been extensively cleared for settlement. Certain areas of the original forest have, however, been preserved by the natives for religious reasons. In these sacred groves or "kaya," as they

are called, the elderly people make their homes in central clearings and when they die are buried there. Apart from the central clearings and paths which lead to them, the groves are undisturbed forest, in which may be found wild pig, monkeys and small antelopes such as dik-dik. They still provide breeding places for *G. austeni* and are shunned by native stock-owners.

Mariakani itself is 26 miles by road from Mombasa and is at an altitude of about 600 feet. The grove selected for the experiments is known as Kaya Fungo and is about 7 miles from Mariakani. There was adequate grazing, and water was provided by the construction of a dam across a small wet-weather stream. Cattle were kraaled at the edge of the "kaya" and grazed in the forest fringes, where the tsetse flies were active. Once daily they were driven along a path into the forest itself and the intensity of the attack by tsetse was observed.

This site offered the advantage that little harm would be done if the tsetse flies became infected with drug-fast trypanosomes, since—apart from other "kayas"—there is no tsetse-infested country within a radius of 30 miles. As has already been stated, no case of drug-fastness was encountered, which may in part have been due to the careful quarantine of any cattle which showed trypanosomes in the blood after drug treatment.

Originally three groups of cattle were sent to Kaya Fungo, which were augmented later by the birth of calves, the bulls and heifers making 2 different groups, and the addition of 1 further group; there were thus eventually 6 groups as follows:—

(1) *Controls.* Eight cattle received no treatment.

(2) *Monthly treatment group.* Twenty cattle received injections of antrycide chloride/sulphate mixture monthly.

(3) *Group treated during alternate months.* Twenty cattle received treatments with antrycide mixture every second month.

(4) *Bull calves.* The bull calves received therapeutic treatments with antrycide sulphate only on grounds of clinical necessity.

(5) *Heifer calves.* The heifer calves received 2 treatments with the prophylactic antrycide mixture at birth and at 6 weeks old. Thereafter, they received only therapeutic treatments with antrycide sulphate on grounds of clinical necessity, as in the case of the bull calves.

(6) *Group receiving treatment every 3 months.* Owing to the success with prophylactic treatment at one- and two-monthly intervals a third group of 20 cattle was subsequently added, which received injections of antrycide chloride/sulphate mixture at three-monthly intervals.

II. Control Groups

Trypanosoma vivax was found in the blood of 6 of 8 cattle in 16 to 109 days, average 51 days. Two cattle did not become infected with *T. vivax*. *T. congolense* was found in the blood of all controls in 21 to 63 days, average 45 days. Two cattle were successfully treated and added to the experimental groups, the remaining six were left until they died. Survival time was 58 to 180 days, average 117 days.

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The long incubation period is worthy of remark, but in spite of this the disease was evidently sufficiently severe to provide an adequate test of the prophylactic properties of antrycide.

III. The Groups of Cattle Which Received Regular Prophylactic Injections

The prophylactic injections given were a mixture of the antrycide chloride and sulphate. The chloride injection corresponded to a dose of 10.0 mg./kilo and the sulphate of 5.0 mg./kilo. Latterly, pro-salt was used.

Group 2. Twenty cattle received monthly injections of prophylactic mixture and were exposed to tsetse flies continuously from 19/5/50 and 29/5/50. The experiment was still in progress at the time of writing, 29/9/52. Three cattle

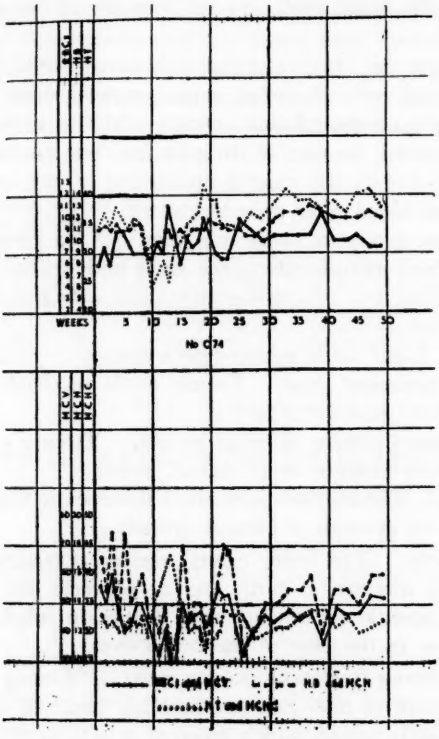

CHART IX

from the group were sent to Kabete on 20/6/50, and 3 more on 20/11/50, leaving a balance of 14. Of these, 8 still survive. There have been no losses from trypanosomiasis; deaths have been due to East Coast Fever and snake bite.

During this time, infection with *T. vivax* or *T. congolense* has been diagnosed in 4 cattle by blood or gland smear examination. The infections were scanty and transitory. They occurred after 12, 13, 24 and 24 months respectively.

Hæmoglobin estimations were made of all cattle at weekly intervals by the

Tallquist method. Hæmoglobins initially averaged 80 per cent, but fell after 4 weeks to 60/70 per cent.

Trypanosomes were never demonstrated by blood or gland smear examination in the cattle sent to Kabete. Physical examinations of the blood of these cattle were made at weekly intervals. Chart IX is representative of the changes found in the blood of these cattle. Changes similar to those of chronic or cryptic trypanosome cases (*vide supra*) will be noted. These changes were more marked in the cattle brought to Kabete after 1 month's exposure to tsetse flies than in those exposed for 6 months.

Group 3. Twenty cattle received injections of prophylactic mixture every second month and were exposed to tsetse flies continuously from 20/5/50 and 29/5/50, except for 3 cattle sent to Kabete on 19/7/50 and 3 on 19/10/50. Of the 14 remaining cattle, 12 survived at 29/9/52. Deaths have been due to East Coast Fever.

T. vivax infection was diagnosed after 15 months in 2 cattle and with *T. congolense* after 24 months in 3 cattle. All infections were scanty and transitory. Hæmoglobin estimations showed a fall after 4 weeks in contact with tsetse flies from 80 per cent to 60 to 70 per cent by the Tallquist scale.

Cattle sent to Kabete never showed trypanosomes in blood or gland smears, but physical blood examinations showed changes similar to those of Group 2. These changes were more marked in the 3 cattle sent after 2 months' exposure to tsetse flies than in those exposed for 5 months.

Group 6. Twenty cattle received antrycide sulphate/chloride mixture on 27/1/51 and were exposed to tsetse flies on the same day. The injections were repeated at three-monthly intervals. Of these, 4 cattle became infected with *T. vivax* or *T. congolense* before the second three-monthly injection was given; 2 cattle became infected before the third injection was given. The group was then discarded.

General. Davey (1950) had forecast that prophylactic injections of antrycide, given every 3 months, would prove sufficient to give protection to cattle exposed to tsetse fiies. Results given above indicate that this was over-optimistic.

TABLE 4

Showing results of blood physical examinations of 12 normal adult cattle and 2 groups of cattle exposed to tsetse flies, which had received monthly (Group 2) and alternate monthly (Group 3) injections of prophylactic antrycide.

	RBC	Hb	Ht	MCV	MCH	MCHC
Normal ...	8.2	11.8	38 per cent	47 cu_u	15 yy	32 per cent
Group 2 ...	6.6	11.0	34 per cent	50 cu_u	17 yy	33 per cent
Group 3 ...	5.7	10.0	30 per cent	53 cu_u	18 yy	34 per cent
Significance P	<0.02	<0.001	<0.1			

RBC = red blood cells, millions per c.mm.
Hb = hæmoglobin, grammes per 100 c.c.
Ht = hæmatocrit, packed red cells per cent.
MCV = mean corpuscular volume.
MCH = mean corpuscular hæmoglobin.
MCHC = mean corpuscular hæmoglobin concentration.

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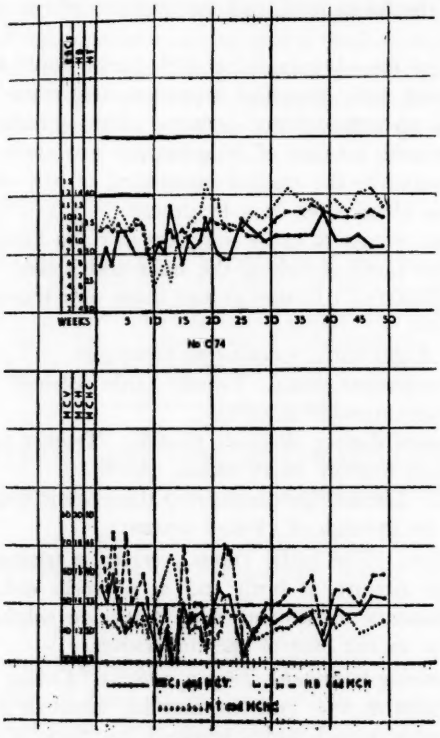

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Group 3. Twenty cattle received injections of prophylactic mixture every second month and were exposed to tsetse flies continuously from 20/5/50 and 29/5/50, except for 3 cattle sent to Kabete on 19/7/50 and 3 on 19/10/50. Of the 14 remaining cattle, 12 survived at 29/9/52. Deaths have been due to East Coast Fever.

T. vivax infection was diagnosed after 15 months in 2 cattle and with *T. congolense* after 24 months in 3 cattle. All infections were scanty and transitory. Hæmoglobin estimations showed a fall after 4 weeks in contact with tsetse flies from 80 per cent to 60 to 70 per cent by the Tallquist scale.

Cattle sent to Kabete never showed trypanosomes in blood or gland smears, but physical blood examinations showed changes similar to those of Group 2. These changes were more marked in the 3 cattle sent after 2 months' exposure to tsetse flies than in those exposed for 5 months.

Group 6. Twenty cattle received antrycide sulphate/chloride mixture on 27/1/51 and were exposed to tsetse flies on the same day. The injections were repeated at three-monthly intervals. Of these, 4 cattle became infected with *T. vivax* or *T. congolense* before the second three-monthly injection was given; 2 cattle became infected before the third injection was given. The group was then discarded.

General. Davey (1950) had forecast that prophylactic injections of antrycide, given every 3 months, would prove sufficient to give protection to cattle exposed to tsetse fiies. Results given above indicate that this was over-optimistic.

TABLE 4

Showing results of blood physical examinations of 12 normal adult cattle and 2 groups of cattle exposed to tsetse flies, which had received monthly (Group 2) and alternate monthly (Group 3) injections of prophylactic antrycide.

	RBC	Hb	Ht	MCV	MCH	MCHC
Normal ...	8.2	11.8	38 per cent	47 cu_u	15 yy	32 per cent
Group 2 ...	6.6	11.0	34 per cent	50 cu_u	17 yy	33 per cent
Group 3 ...	5.7	10.0	30 per cent	53 cu_u	18 yy	34 per cent
Significance P	<0.02	<0.001	<0.1			

RBC = red blood cells, millions per c.mm.
Hb = hæmoglobin, grammes per 100 c.c.
Ht = hæmatocrit, packed red cells per cent.
MCV = mean corpuscular volume.
MCH = mean corpuscular hæmoglobin.
MCHC = mean corpuscular hæmoglobin concentration.

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In the one- and two-monthly groups, positive blood or gland smears were found in only 9 of the remaining 28 cattle in 28 months. No infections occurred before the 12th month and those which did occur were very scanty and disappeared without the necessity of extra treatments. This would appear to indicate a high degree of success for the prophylactic treatments. The fact, however, that these transitory infections had occurred, together with the diminution of the hæmoglobin level of the blood, suggested that an occult infection might be found to exist. This was further suggested by results with the cattle sent to Kabete.

These possibilities were subsequently examined in other ways (*vide infra*). Meanwhile, samples of oxalated blood were drawn weekly at random from cattle in Groups 2 and 3 and sent to Kabete for more detailed examination. Results are given in Table 4. The group of cattle which received injections of antrycide monthly showed statistically higher figures for red cells, hæmoglobin and hæmatocrit than did the group which received antrycide every second month. The two groups of cattle were obtained from the same source at the same time and were separated at random. As has already been shown, the monthly administration of antrycide does not affect the blood picture. It is, therefore, to be supposed that the improved figures in the group treated monthly are due to the control to a greater extent of cryptic infection.

Figures for the group receiving antrycide monthly are also low, but cannot be regarded as lying outside the normal range.

TABLE 5

Showing the histories of a group of bull calves born and maintained in contact with G. austeni *at Kaya Fungo.*

No.	Days TV+	Days TC+	Days 1st	Days 1st/2nd	Days 2nd/3rd	Days 3rd/4th
110	101	146	207	50	122	
114	90	83	120	87	95	
115	113	109	119	170	126	
116	89	82	137			
117	141	87	177	died		
120	134	131	170	120	118	
122	132	132	177	55	93	
123	175	279	308			
124	224	72	106	71	55	56
125	131	128	170	40		
131	112	109	145			
132		47	died			
134	73	54	89	107	139	
135	160	227	161			
Average	129	120	160			

TV = *T. vivax.*
TC = *T. congolense.*
Days 1st = days from birth before first treatment with antrycide sulphate.
Days 1st/2nd = days between first and second treatments with antrycide sulphate.

IV. Results in Cattle Born at Mariakani

All the cows sent to Kaya Fungo produced normal healthy calves and returned to the bull. The second parturitions also proceeded normally. The present section deals with the first batch of calves born there, Group 4 bull calves, and Group 5 heifer calves. All calves at birth were normal and healthy. Blood smears were negative and hæmoglobins were normal by the Tallquist scale at 80 per cent.

It was wished to determine whether by a limited number of therapeutic treatments at lengthening intervals the calves could be reared to adult life with an acquired tolerance or resistance, which would render further treatments unnecessary. The bull calves therefore received no treatment until this was necessitated on clinical grounds. The heifer calves, which it was not wished to lose because of their possible value as breeding stock, received a prophylactic treatment at birth; this did not fully protect them, probably because the initial dose became insufficient for the growing animal; it was therefore repeated at 6 weeks in time to forestall infection.

Results with the 2 groups are given in Tables 5 and 6. One of 10 heifers never showed *T. vivax* in blood or gland smears, but all became infected sooner or later with *T. congolense*. Only 1 bull of 14, which died early, failed to become infected with *T. vivax*; all became infected with *T. congolense*. The average time taken for the appearance of *T. vivax* and *T. congolense* in the bull calves, heifer calves and untreated controls and the average survival time

TABLE 6

Showing the histories of a group of heifer calves born and maintained in contact with G. austeni *at Kaya Fungo; the calves received treatment with antrycide chloride plus sulphate at birth and at 6 weeks old; the table shows the subsequent treatments with antrycide sulphate.*

No.	Days TV+	Days TC+	Days 1st	Days 1st/2nd	Days 2nd/3rd	Days 3rd/4th
111	273	185	188	199		
112	84	244	98	150		
113	killed accidentally on 16/8/51; never became positive					
118	177	279	296	103		
119	342	77	151	30	42	51
121	died on 13/3/51; never became positive					
126	362	275	292			
127	361	191	196	193		
128	235	354	282			
129		196	199	73		
130	239	125	126			
133	321	204	209			
Average	276	213	195			

TV = *V. vivax*.
TC = *T. congolense*.
Days 1st = days from birth before first treatment with antrycide sulphate.
Days 1st/2nd = days between first and second treatments with antrycide sulphate.

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of the controls compared with the first treatments given to the calves is shown in Table 7. The greater natural resistance of calves exposed from birth to tsetse is evident. The calves were immunised against rinderpest with attenuated goat virus without ill-effects, and castration of the bulls likewise caused no losses.

TABLE 7

Showing the average time taken for the appearance of T. vivax *and* T. congolense *in bull calves, heifer calves and untreated controls, and the average survival time of the controls, compared with the first treatment of the calves; all cattle were exposed to* G. austeni *at Kaya Fungo.*

	Days TV+	Days TC+	Survival or first treatment, days
Bull calves	129	120	160
Heifer calves	276	213	195
Controls	50	45	117

Days TV+ = days between exposure to tsetse flies and development of *T. vivax* infection.
Days TC+ = days between exposure to tsetse flies and development of *T. congolense* infection.

Weekly hæmoglobin estimations were made by the Tallquist method and revealed a fall in all from an initial figure of 80 per cent to 70 per cent and lower. In spite of this, weight increases during the first year of life compared favourably with those of calves not exposed to tsetse flies. Blood samples were sent in ice to Kabete for examination, and comparative figures are given in Table 8. An anæmic condition is apparent, but is not of great severity.

TABLE 8

Showing a comparison between average blood figures of Groups 2 and 3, the calves, and normal adult cattle and calves.

	RBC	Hb	Ht	MCV	MCH	MCHC
Group 2	6.6	11.0	34 per cent	50 cu	17 yy	33 per cent
Group 3	5.7	10.1	30 per cent	53 cu	18 yy	34 per cent
N. adults	8.2	11.8	38 per cent	47 cu	15 yy	32 per cent
N. calves	8.4	10.1	35 per cent	42 cu	12 yy	29 per cent

RBC = red blood cells, millions per c.mm.
Hb = hæmoglobin, grammes per 100 c.c.
Ht = hæmatocrit, packed red cells per cent.
MCV = mean corpuscular volume.
MHC = mean corpuscular hæmoglobin.
MCHC = mean corpuscular hæmoglobin concentration.

At the end of 1951, the European Officer stationed at Mariakani was transferred to other duties. In consequence, instructions were received that no further treatments were to be given to the calves for fear of misuse of antrycide by unqualified African staff and dissemination of drug-resistant trypanosomes. No further treatments were therefore given either to the original calves, which were about 12 months old, or to the newly-born calves, which were dropped during November and December. All these calves continued to thrive, in spite of the lack of treatment, until the onset of the long rains in May, 1952—

that is to say, for a period of some 6 months and in many cases longer. The colder weather, however, resulted in exacerbation of the infection, and over the next 4 months the majority of the calves died from trypanosomiasis.

It is plain that cessation of treatment was premature. In the case of the first-born calves, an average of 4 treatments were judged necessary during the first year; during the second year, no treatments were necessary for 6 months, after which they were not permitted. The second-born calves, on the other hand, survived for 6 months in good condition without the necessity of any treatments. By this is indicated a progressive increase in the capacity to resist or tolerate infection. But for the limitations imposed on this experiment, it may be supposed that useful results would have been obtained. The writer (Fiennes, 1952, *d*) in giving some account of these results has already expressed the opinion that research on these lines gives the best hope of finding a means of raising cattle in contact with tsetse flies.

V. The Effect of Surgical Removal of the Antrycide Depot

Subcutaneous injection of antrycide chloride causes hard swellings beneath the skin, which may persist for 5 or 6 months. These are unsightly but not harmful. The drug forms a depot inside the swelling, which appears to be fibrous. A number of small blood vessels are developed, which supply the capsule of the swelling. Curd and Davey (1950) tested the effect on protection against trypanosomiasis of surgical removal of the depot from rabbits. It was found that when the depot was removed the rabbits again became susceptible to infection.

This work was repeated in cattle at Mariakani. Six cattle received injections of antrycide chloride/sulphate mixture; the depot was to be removed in 2 cattle 1 month after exposure to tsetse, in 2 cattle after 2 months, and in 2 cattle after 3 months. In the first two groups, trypanosomes, either *T. vivax* or *T. congolense*, were found in blood smears 18 to 72 days after removal of the depot, with an average of 38 days. In the third group, the depot had been absorbed in one of the cattle, which shortly after became infected with both *T. vivax* and *T. congolense*. The depot was removed from the other animal, which became infected with *T. vivax* after 69 days and with *T. congolense* after 60 days.

The incubation period with controls (*vide supra*) was 16 to 109 days, so that following removal of the antrycide depot these cattle became infected with trypanosomiasis within a normal incubation period.

VI. The Effect of Intercurrent Infection

A group of rinderpest-susceptible cattle was sent to Kaya Fungo and received prophylactic antrycide at two-monthly intervals. At approximately monthly intervals, 2 of the cattle were given injections of attenuated rinderpest goat virus, to see whether this would affect the protection afforded by the antrycide. Good temperature reactions resulted from the rinderpest injections. Four cattle of 16, provoked in this way, developed positive blood smears for either *T. vivax* or *T. congolense*.

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VII. Sub-inoculation Experiments

Attempts were made to reproduce trypanosome infections in clean cattle by sub-inoculations of blood and tissues from antrycide-protected cattle, which had been exposed to tsetse flies. Blood or tissues were injected into clean cattle on 29 occasions, both one- and two-monthly groups being used. In some cases, as much as 40 c.c. of blood was injected on each of 5 consecutive days. In no case did any of the clean animals develop infections with trypanosomes.

VIII. The Results of Autopsies on Antrycide-protected Cattle Exposed to G. Austeni

Autopsies were performed at intervals on 6 cattle, which received protective antrycide at one- and two-monthly intervals and were exposed to tsetse flies. In all cases, except one, there were changes in the organs similar to those encountered in the Kiboko autopsies, but generally less severe.

Splenomegaly was a constant feature. There was enlargement and fibrosis of the lymphatic glands and a general tendency to hyperplasia of the hæmolymph system. In all cases, red marrow was present in the sternum, ribs and vertebræ, but deficient in the long bones. In 3 cases, there were subepicardial hæmorrhages.

It is worthy of note that lesions were more severe in the cattle which had only been exposed to tsetse flies for a short time. In the one animal which showed little abnormality, exposure had been for 434 days.

IX. Results of Parasitological Examination of Tissues from Cattle Protected with Antrycide and Exposed to G. Austeni

Tissue smears from the 6 cattle autopsied were examined for the presence of trypanosomes. These were found in the hearts of all 6 cattle. In 5, they were also present in the lungs. A single trypanosome was found in the adrenal smear of one animal and in the smear from the prescapular gland of another.

Intact or viable trypanosomes were infrequent but parasites in various stages of lysis were numerous. These were identified by the presence of nucleus, kinetoplast and axoneme, and were similar to those found in the hearts of cattle at Kiboko (*vide supra*).

X. Provocation by Shock

Seven cattle, which were receiving injections of pro-salt every second month, were removed from Kaya Fungo to Kabete. After 30 days at Kabete, during which blood and gland smears remained negative, they received injections of 5 c.c. of TAB vaccine, followed by twice-daily injections of adrenalin (6 c.c. 1/1,000) for 3 days. Blood smears from 4 of the 7 cattle showed *T. congolense* within the next 30 days.

XI. Treatment Experiments on Cattle infected with Trypanosomiasis following Exposure to G. austeni

Fifty-one cattle were exposed to *G. austeni* at Kaya Fungo for periods varying from 1 to 2 weeks. The object was to create a chronic form of trypanosomiasis and to treat as late in its course as possible. The cattle all

developed trypanosomiasis due to *T. vivax* or *T. congolense,* or both. A synopsis of results is given in Table 9.

TABLE 9

Showing the results of treatment of cattle, which were chronically infected with T. vivax *and* T. congolense*; the cattle were treated as late in the course of the disease as possible.*

		Average period
Cattle which died before treatment	11	
Cattle cured	10	
Cattle which died after treatment	5	9 days
Cattle which relapsed with *T. congolense*	11	42 days
Cattle which relapsed with *T. vivax*	5	44 days
Cattle which relapsed with both	9	40 days
Total number of cattle	51	

Of 40 cattle treated, 25 relapsed and 5 died; 10 were cured. The average time between treatment and relapse was 42 days.

It is not considered that these results invalidate earlier work on the therapeutic properties of antrycide. The acute type of disease, which had previously been studied, presents little difficulty over treatment. It is often not realised what an intractable disease is the chronic form, such as is often encountered under field conditions. In the present instance, all relapses were cured by a second injection of antrycide.

It is important to note the prolonged period of 42 days between treatment and relapse. In the case of routine field treatment, this might well have been attributed to reinfection. In these cases, too, the incubation period varied between 15 and 268 days. Since the cattle were only exposed to infection for 1 to 2 weeks, this represents a true incubation period and shows how long a time it may take for the disease to develop under conditions of temporary exposure to infection.

The treatment used in all cases was antrycide sulphate at 5.0 mg./kilo.

PART III

I. Discussion

It is clear that misuse of antrycide may have dangerous consequences. Both *T. vivax* and *T. congolense* collected from Kiboko after antrycide had been used there failed to respond to antrycide in the original hosts and in cattle —and in the case of *T. congolense* mice—sub-inoculated from them. There is no evidence that antrycide-fast *T. vivax* was also dimidium-fast, but *T. congolense* collected from antrycide-protected cattle was mostly fast to both drugs. A strain of *T. congolense* collected from a dimidium-protected ox was dimidium-fast and partially antrycide-fast. The dangers of cross-fastness between aromatic drugs were stressed by Yorke (1932), and these results confirm his warning.

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The experiments described have not shown conclusively whether this fastness is the result of constant exposure of a single trypanosome strain to small doses of the drug or whether the effect of prophylaxis with antrycide had been to select naturally resistant strains already present in the area. The development of enhanced resistance in four strains of *T. congolense* collected from oxen that were treated with antrycide and repeatedly challenged shows that a single strain may vary in its resistance to the drug; this would appear to be the more probable explanation.

The dangers of creating drug-fastness are therefore well established. It is, however, possible that these dangers may be less serious than was previously supposed. Lost of fastness in a strain of *T. congolense,* although it was passaged only in cattle, shows that the development of fastness in this trypanosome is not an irreversible process. Doubt is thrown by this on the conception of the development of fastness as an irreversible mutation.

It has not been possible to transmit trypanosomiasis by sub-inoculation of blood and tissues from antrycide-protected cattle, where blood and gland smears were negative. It would seem, therefore, that antrycide can be safely used at one- or two-monthly intervals, provided that cattle which develop blood infections are quarantined until clear again. It would seem that it may continue to be effective in this way almost indefinitely. The possibility that in time its use might be discontinued has not been tested, but there is some evidence from the results at Kiboko that under protection with antrycide cattle become increasingly resistant to trypanosome infections. Injections at more than two-monthly intervals would appear to be inadvisable.

In spite of these satisfactory results, it is evident that care must be exercised over the use of antrycide as a prophylactic. In 4 cases of 16, rinderpest-susceptible cattle became infected with trypanosomiasis in spite of antrycide, when injected with attenuated rinderpest virus. Infection developed in 4 cases of 7 when the cattle were provoked with TAB vaccine and adrenalin injections.

Furthermore, there is good evidence that cattle protected with antrycide and exposed to tsetse flies are not absolutely protected, but suffer from a cryptic form of infection, comparable to a premunity. This is shown by the late appearance of trypanosomes, in small numbers and temporarily, in the blood and gland smears of some of the antrycide-protected cattle. On post-mortem examination, lesions were found indicative of cryptic trypanosome infection and trypanosomes were found in smears from various organs. Intercurrent infection and shock treatment were able to induce the appearance of trypanosomes in the blood of some of the cattle so treated. There were anæmic changes, such as are associated with cryptic trypanosome infections. Finally, physical examination of the blood of cattle in the one- and two-monthly injection groups showed that those receiving monthly injections were less severely affected than those receiving injections every second month.

Much of this evidence may be considered circumstantial; but regarded as a whole, it is difficult to believe that the antrycide-protected cattle were not

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carrying an infection of low grade, especially as it was possible to show that cattle may carry an infection of this type.

It is less easy to decide the nature of the infection. Is it: (1) cryptic and durable, (2) transitory and repeated, (3) durable, but also subject to super-infection? The splenomegaly, encountered both at Kiboko and Mariakani, suggests an early stage of the disease; it is not compatible with late chronic trypanosomiasis (Fiennes, Jones and Laws, 1946). From this it may be deduced that the infection, under conditions of repeated attack by tsetse flies, is continually renewed. The small numbers of parasites found in tissues post-mortem and the preponderance of forms in various stages of lysis support this view. There is some evidence that, in spite of this renewal of the infection, persistent infection also exists. This is suggested by the chronic anæmic changes found in the cattle brought to Kabete from Mariakani, by the demonstration of trypanosomes in the bloods of cattle many months after being removed from Kiboko, and by the appearance of trypanosomes in the bloods of cattle brought to Kabete from Mariakani and provoked with TAB and adrenalin.

The evidence suggests, therefore, that antrycide-protected cattle exposed to tsetse flies:—

(1) Become infected with trypanosomiasis in spite of negative blood and gland smears;

(2) That this infection may persist for long periods after removal of the cattle from contact with tsetse, but may disappear without parasites ever being demonstrated in blood or gland smears; and

(3) That for so long as the cattle remain in contact with tsetse flies, super-infection may occur.

These views, at first sight, appear to be contrary to accepted ideas about the mechanism of premunity; where a premunition focus exists, it is believed that super-infection cannot normally occur. It must, however, be remembered that there exist many antigenic strains of *T. congolense*, in all likelihood of *T. vivax* too; there is no reason to suppose that a premunition focus of one strain will inhibit infection with another.

The degree of protection afforded by antrycide appears to be dependent on three factors:—

(1) The dose of antrycide and the frequency of repetition;

(2) The effectiveness of the animal's own powers of resistance, either natural or acquired; and

(3) The intensity of the challenge, which may depend on the frequency and possibly also on the numbers and virulence of the parasites.

In mice, pro-salt appeared to give complete sterile immunity; other preparations gave partial protection, as shown either by the late appearance of trypanosomes in blood smears or else by demonstration of their presence in the tissues or by sub-inoculation of blood. In the latter case, it appears that foci of parasites become established in certain organs; that there are periodical attempts at invasion of the blood; that these attempts prove abortive. Such appears to be the condition in mice and explains equally well what happens in

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cattle exposed to tsetse flies. Davey's (1950) satisfactory results in the laboratory, not repeated in the field tests, are also explained on this hypothesis. Furthermore, Ormerod's (1951) explanation of the mode of action of antrycide gives independent support.

The experiments with calves born at Mariakani have shown how much more resistant young stock are than adults. They have shown also that there is a progressive increase of resistance to trypanosomiasis resulting in a lengthening of the interval between treatments. It was not possible to carry these experiments to fruition, but encouragement is given to the belief that, by means of a comparatively small number of treatments given only when necessary, stock may be raised with the capacity to survive in tsetse areas.

The treatment experiments may appear, at first sight, to be disappointing. The conditions of the test were, however, more drastic than have probably been applied to any drug. Chronic trypanosomiasis is not easily cured in any animal, and the fact that in the majority of cases two injections of antrycide were necessary in place of the recommended one need cause little concern.

The dose of antrycide throughout, when used as a therapeutic agent, has been 5.0 mg./kilo, that recommended by the manufacturers. No signs of toxicity have been observed in calves or adults, and there is no confirmation of reports of immediate or delayed poisoning. It may be noted that the Coast Province of Kenya is an area where dimidium bromide cannot be used with safety, so that in this area at any rate there is an alternative drug.

II. Conclusions

(1) Improper use of antrycide chloride as a prophylactic may lead to the dissemination of trypanosomes, fast to both antrycide and dimidium.

(2) Under proper conditions of use, antrycide chloride is not dangerous from the aspect of transmitting drug-fast trypanosomes. Furthermore, there is evidence that in the case of *T. congolense* drug-fastness may not be a persistent characteristic. It is possible that its dangers have been overestimated and it proved impossible to transmit trypanosomiasis from antrycide-protected cattle, although they appear to have carried a low-grade infection.

(3) Cattle were maintained in country infested with *G. austeni* in apparent health for 28 months; injections of antrycide chloride/sulphate mixture were given at one-monthly intervals to one group and at two-monthly intervals to a second group. A number of cattle in a third group, which received antrycide at three-monthly intervals, developed trypanosomiasis and the group was discarded.

(4) Scanty and transitory infections with either *T. vivax* or *T. congolense* were diagnosed in blood or gland smears from 9 cattle during the course of the experiment. Originally there were 28 cattle, of which 20 survived at the end of the experiment.

(5) There is evidence that, in spite of these apparently favourable results, the cattle suffered from a cryptic form of trypanosomiasis, which was not transmissible. Protection afforded by antrycide, therefore, resulted from the creation of a premunition focus.

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(6) Studies in mice and cattle suggest that the degree of protection afforded by antrycide is dependent on the following factors:—

(*a*) The dose and frequency of repetition of antrycide;

(*b*) The natural or acquired resistance of the animals treated; and

(*c*) The intensity of the challenge.

(7) Evidence suggests that antrycide does not destroy the parasites immediately on injection into the body, but inhibits or destroys them at the stage of multiplication at the end of the incubation period.

(8) It has been established that a cryptic form of trypanosomiasis exists in cattle, which is accompanied by anæmia and tissue changes. In these cases, trypanosomes may be demonstrated in the cardiac capillaries; the majority are in a state of lysis.

(9) Calves showed a markedly higher resistance to trypanosomiasis than did adult cattle. The disease in calves could be controlled by the use of antrycide sulphate as a therapeutic agent. Under such a routine, the necessity for treatment became more infrequent as time went on.

(10) Antrycide sulphate was unable to cure all cases of chronic *T. vivax* and *T. congolense* in a single injection; repeat dosage was effective. This result was probably as good as would have been obtained with any other drug under the very drastic conditions of this experiment.

III. Acknowledgments

It will not be out of place to give acknowledgment of the generous gift of nearly £16,000 from Colonial Development and Welfare Funds, which has enabled this work to be done on a sufficient scale.

All antrycide has been supplied free of charge by Messrs. Imperial Chemical (Pharmaceuticals), Ltd. I wish to thank them for this and also for constant help and co-operation. It was with great pleasure that we welcomed Dr. D. G. Davey to this laboratory in 1948 and it is from his researches that the present work has arisen.

The work has been under the joint direction of the Director of the E.A. Tsetse and Trypanosomiasis Research and Reclamation Organisation, Dr. H. M. O. Lester, and by the Director of the E.A. Veterinary Research Organisation, Mr. H. R. Binns. I am indebted to both directors for assistance and advice. With these remarks I wish also to associate Dr. E. A. Lewis, who was acting Director of E.A.T.T.R.R.O. for some months during 1951 and again in 1952.

We are indebted to the Provincial Administration of the Coast Province of Kenya for help in establishing the experimental site at Kaya Fungo, and in particular to Mr. J. Stringer, District Commissioner, Kilifi. We have also received every assistance from the Kenya Veterinary Department and our gratitude is due to the late Director of Veterinary Services, Mr. E. Beaumont, and to the present Director, Mr. R. A. Hammond. Mr. Hassan, Veterinary Officer, Mombasa, and Mr. Ahmed, Assistant Veterinary Officer, Mariakani, have also given us much practical assistance.

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The work has entailed the keeping of very voluminous records, in which I have been assisted at different times by Mrs. Barnett, Mrs. Fiennes and Mrs. Hempsted. This has relieved me of much work of a routine nature and I am grateful for the careful and conscientious way in which the ledgers were kept.

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CONCISE HISTORY OF VETERINARY SCIENCE IN EGYPT

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It may be interesting to give the concise history of Veterinary Science in Egypt.

Written documents, papyrus rolls, kept in earthenware containers, were discovered at Fayoum district, *2,000 years B.C.*, describing efficient means of treatment in animals, conjunctivitis in oxen and intestinal parasitic infection in dogs.

Efficient means of treatment of animals by cauterisation, seatoning and bleeding were recorded by ancient Egyptians whose means were almost the same as those used to-day.

In 1827 the first veterinary college was started in Egypt through the outbreak of cattle plague among cattle used in the process of polishing rice.

That first college was situated at Rasheed and graduates were treated in every respect as graduates of the medical college.

In 1831 a better equipped college and an infirmary as well as premises for staff and students were established near the Army quarters at Abu-Zabal and 100 students were admitted.

Six years later the Veterinary College was joined to the Medical College at Kasr-el-eini, a real setback, but it was only for one year as in 1838 the Veterinary College was separated and transferred to highly-equipped premises in Shubra, near Cairo. A hundred and twenty students were admitted to a course of five years of instruction, including physics, chemistry, botany, zoology, anatomy, physiology, pharmacy, materia medica, medicine, surgery and breeding. That college had an animal hospital for 1,000 animals and this was over 100 years ago.

In 1839 the College of Agriculture was joined to the Veterinary College until 1869 when the Veterinary College was again returned to the Faculty of Medicine, Kasr-el-eini, another setback ending in 1881 in closing down of the Veterinary College until 1901.

The present college nucleus started in 1901 in Cairo and finally in Giza, its present situation.

The old veterinary schools owed their activities to French veterinarians, but to-day's college and staff owe a very great deal and are indebted to British veterinarians and British veterinary colleges and during the last few years to American Institutes.

Since 1938 both the Veterinary College and services have been conducted by Egyptian graduates.

The present Veterinary College course extends over five years and post-graduate courses, including a thesis, extend over a minimum of three years.

The number of students this session is 416 and the staff number 50.

Since 1938 the Veterinary College is now a Faculty attached to Cairo University.

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The veterinary services have expanded and good work goes on at the Laboratories at Abbassia (Cairo) and Giza.

The veterinary services also include the following sections: contagious diseases, quarantine, abattoir and skin sections.

The veterinary profession in Egypt looks forward to a great future.

REVIEWS

REPORT ON ANIMAL HEALTH SERVICES FOR THE YEARS 1949, 1950 AND 1951. Including Report for 1949, 1950 and 1951 of Proceedings under the Diseases of Animals Acts. 1953. London: H.M. Stationery Office. Price 3s. 6d. net.

THE report on the work of the Animal Health Division of the Ministry of Agriculture and Fisheries for the years 1949, 1950 and 1951 was issued in June, 1953, and it includes an account of the extensive series of outbreaks of foot-and-mouth disease which occurred in the last six weeks of 1951. There were only 15 outbreaks of this disease in 1949 and 20 in 1950; the type of virus encountered was, with one exception, the "O" type. The most likely origin of these outbreaks was swill containing imported meat and household scraps, and seagulls, rooks or vermin sometimes appeared responsible because of their habits of scavenging in refuse tips or dumps. During the late summer of 1951 a rapid build-up of foot-and-mouth disease was taking place in Western Germany, Denmark, Holland and Belgium, and it was expected that it would make its appearance in the eastern part of England in the autumn; 88 outbreaks were confirmed during the period November 14 to December 31, 1951, making a total of 116 for the year. Most of these occurred in the east coast area and they were due to the type "A" virus. The number recorded compares very favourably with the continental countries for in November there were over 45,000 outbreaks in Western Germany, over 12,000 in Holland, and more than 23,000 in Belgium. Cattle at pasture appeared to be more frequently attacked and a study was made of the evidence that birds on migration may be responsible for these epidemiological features. The investigators claim to have established a *prima facie* case against birds, especially starlings on migration, as a means whereby foot-and-mouth disease is introduced into Britain.

After more than a year of freedom from swine fever, this disease reappeared in March, 1950; 450 outbreaks occurred in the last nine months of that year and 1,343 in 1951. Swill was thought to be responsible for many of them and the disappointment that such a small proportion of the pig population are immunised is recorded. If the pig industry is to benefit from the use of crystal violet vaccine then a higher proportion of pigs must be vaccinated.

There was a gradual rise in the incidence of anthrax, from 244 outbreaks in 1949 to 407 in 1951. This increase is attributed mainly to the importation of contaminated feeding stuffs, fertilisers of animal origin, and other animal

products from countries where the disease is endemic. In fact, 74 per cent of the outbreaks were on premises where imported feeding stuffs or artificial manures had been used. Fortunately, it is rare for more than two animals to be affected in the same outbreak, although on one occasion there were 15 from animals grazing on some pastures adjoining the river Trent; the river receives a tannery effluent and flooding of the pastures as well as dredging operations had taken place. Cases were observed on mink farms and infection has for the first time been recorded in the carcass of a domestic cat.

The incidence of the acute European form of fowl pest dropped considerably as soon as it was possible to prohibit imports of poultry carcasses from the Continent, but in October, 1950, a subacute form of the disease appeared in West Suffolk. This form has spread to all parts of the country and complicates the efforts to eradicate the disease. A separate series of outbreaks began in the Scottish islands and coastal districts of Scotland in September, 1949, and the origin and method of spread cannot be established with certainty. It is suspected that infection was introduced from discharge of swill from passing ships and it was ascertained that large numbers of diseased poultry had been dumped into the sea before diagnosis was established. There is little doubt that sea birds may aid the spread of the disease and the virus of fowl pest has been recovered from cormorants and gannets from islands where infection had been found.

The final stage in the campaign against bovine tuberculosis began on October 1, 1950, when a revised Attested Herds Scheme came into operation and a plan was introduced for the eradication of the disease on an area basis. This provides for the compulsory eradication of the disease area by area until the whole country is freed; the voluntary eradication is an essential preliminary operation.

Investigations into many and varied disease problems have been made by the Ministry's Veterinary Laboratory at Weybridge and at the Veterinary Investigation Centres. It is suggested, after examination of carcasses post-mortem, that tuberculosis may be transmitted in cattle by vaginal manipulation or at service; primary infections were also observed in the inguinal glands after castration, the parotid glands after the lancing of a superficial face abscess and the prescapular glands after S.19 vaccination. Another study was made of the infection of bovine udders with acid-fast bacilli which normally are saprophytic; these cases developed after treatment of udders with oily therapeutic substances. Attention is drawn to the importance of nutrition and management in Johne's disease and it is suggested that tick-borne fever in cattle, although mild, may precipitate the onset of diarrhœa in non-scouring cases of Johne's disease. These examples show the importance and value of the studies made upon subsidiary factors as causes of disease and of the factors which may induce the change from a latent infection to an overt case of disease. A limited amount of work has been done on dog diseases and it is interesting to learn of the studies made with viruses isolated from clinically different outbreaks of distemper and " hard pad." Neither immunologically nor serologically could the several distemper viruses

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and "hard pad" virus be distinguished. Lymphocytic choriomeningitis virus is said to occur quite frequently in dogs and ferrets and no clinical symptoms are observed. Many more problems are being studied and although statements are made which one would suggest need modification, the account tells a useful story of the trend and amount of the research work being pursued.

Other sections of the report recount the action taken under various acts and orders and of the regulations made to prevent the introduction and spread of disease in the country. The measures taken to protect animals during transit by sea, rail and road are given as well as the changes in the regulations of countries which import stock from Britain; the export of stock through the quarantine stations also continues.

The appendix, often a valuable part of any report, is in this case worthy of attention for there are over 30 tables and one can learn of the incidence of diseases in this country and in others by a study of the data presented. The number of animals imported into this country, the number of attested herds of cattle in each county in Great Britain at the end of 1951, the quantities of several biological products prepared, and the number of specimens examined at the laboratories are set out in tabular form and contribute to the report which should be an annual one. Even in scientific matters, history is good but current events are more interesting.

A Handbook on Hides and Skins. From the Government Printer, Nairobi. Price 3s. 6d.

The Department of Veterinary Services, Kabete, has recently published a very interesting and comprehensive handbook on the preparation and drying of hides and which also contains a great deal of other information relative to this important industry.

Up to the present time the quality of locally-produced hides in East Africa and elsewhere has been affected very adversely by the methods employed in their preparation and it is hoped that the efforts being made by the veterinary services in Kenya will be successful.

The production of better-quality hides by improved methods of preparation is not as simple a matter as it appears on the surface—as the writer of this review had experience a few years before the war when he spent some time trekking among the nomads and the villages in the Sudan disseminating information on the frame method of hide drying. The main difficulty then was to convince the producer that, having taken the extra trouble and dried his hides on frames, he could be certain that the buyer would be prepared to pay an extra price for them, to make him feel tolerably certain that it would be he and not the middleman who would reap the reward. A frame-dried hide shows very clearly all the blemishes which are to a large extent hidden in the ground-dried article. It only needs a very few frame-dried hides to be down-graded on account of holes, brand marks, etc., to within a few pence of the value of the ground-dried article to convince the local producer that the extra work involved in the more elaborate process is not worth while.

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It is most encouraging to note that the efforts to produce better hides in Kenya are being supported by legislation, timely designed to promote the welfare of the industry and which should do much to overcome many of the old difficulties.

MODERN RABBIT HUSBANDRY, by W. King Wilson. London: Crosby, Lockwood & Son, Ltd. 1953. Price 10s. 6d. net.

A BOOK on rabbit husbandry has been desired by the animal breeders in this country. The author, who is in charge of the Rabbitry at Harper Adams Agricultural College, has done yeoman service by placing at our disposal his knowledge about this interesting animal. The book is divided into 16 chapters, each dealing with different aspects of the life, breeding, keeping, feeding and control of diseases of rabbits. Breeders who are keen on the application of modern scientific methods to their crafts will find this book practical, comprehensive and, above all, highly instructive.

EINFUHRUNG IN DIE ERNAHRUNGSPHYSIOLOGIE DER HAUSTIERE, by Professor Walter Lenkeit 1953. Stuttgart: Ferdinand Enke Verlag. Price 26 DM.

THIS little book, dealing with the nutritional physiology of domestic animals, is very welcome. In the space of about 160 pages it provides a sound introduction to the nutritional requirements of livestock.

The book is divided into five main sections dealing respectively with maintenance requirements and those of pregnancy, growth, lactation and work, each section beginning with a general introduction to the physiological processes involved and then considering energy, protein and other nutritional requirements. There are some 37 illustrations and 92 tables, the great majority of which are very much to the point. In many ways, despite the description of the book as an introduction, the subject matter is dealt with in considerable detail. Those who are familiar with the literature of animal nutrition will be able to make interesting comparisons between the treatments of the subject by Professors Lenkeit and Maynard in their respective books.

A number of references are given in the text and at the end of each chapter, and here perhaps at least one adverse criticism may be made, namely, the absence of accompanying dates for some of the references in the body of the text. That criticism apart, it must be said that the detailed references given are taken from a wider variety of journals, including English and American, than is usually the case with German texts. Printing and paper are good and the binding adequate.

RUSSIAN COMFREY, by Laurence D. Hills. Faber & Faber (1952). Price 15s.

THIS is a book written by an enthusiast and therefore embodying the merits and faults of enthusiasm for a particular subject.

The author has provided an extremely readable account of Russian Comfrey (*Symphytum peregrinum*), describing in his book the history of the plant, its

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modern cultivation and management and its suitability as a food for grazing animals, pigs and poultry.

The main theme of the book appears to be the potential yields of correct strains of comfrey; for example, yields of 100 tons per acre are credited as being within the bounds of possibility. Whereas early work has produced inferior yields of 8 to 20 tons per acre, Mr. Hills believes that either the selection of the wrong variety of plant or poor management has probably been responsible. Although he is an earnest advocate for further trials with this feeding stuff, the author has not hesitated to give evidence of its unsuitability under adverse conditions. An argument of this kind, of course, cannot be summarised and apart from the fact that the book is in itself very readable, it should interest most veterinary surgeons on account of the potential value of comfrey as a food for livestock.

Having made this recommendation, i.e., that it should be read, the reviewer can now indicate certain apparent faults in the text. The writer does not seem to be very happy when he gets down to chemical details, as in the short paragraph on protein (page 27), the curious formula for allantoin (page 141), or in the reference to ash analysis on page 154. With regard to the veterinary significance of comfrey, Mr. Hills shows caution at times, e.g., page 90, but on the other hand he provides an appendix on "Veterinary Uses of Comfrey" which, in the reviewer's opinion, is not very commendable, being limited to two pages, and almost implying that the plant is a "cure-all."

One point which is made by the author concerning comfrey deserves particular notice because it applies to so many other plants, very few of which have been the subject of large-scale and systematic research in order to improve their value for livestock. The reviewer agrees that in such respects we are probably too timid and conservative in outlook. This book is not for the conservative or complacent.

THE MEAT TRADES JOURNAL. London. Price 6d. weekly.

IT is a curious fact that while the veterinary surgeon will often be at very considerable pains to safeguard the health of farm stock and do everything in his power to ensure that the food animals reach a suitable age for slaughter in as good a condition as possible, once slaughter has taken place and the carcass has passed the meat inspectors his interest in the object of his care suddenly and completely evaporates and he regards the further fate of the food which he has helped to produce with indifference. This, to say the least, is strange because it is precisely the final metamorphosis, the conversion of meat into money, which is the linchpin which holds together the whole of agriculture and veterinary farm practice. If the side of beef or bacon finds a ready market the work of the farmer and the professional services of the veterinary surgeon have been worth while. If the carcass proves to be unsaleable, if the public evince a marked preference for foreign produce, if legislation is brought in which exerts an adverse effect on home-grown meat, then the bottom must fall out of British agriculture and the full force of the disaster will be reflected upon the

veterinary surgeon. Events on the meat market and general news from that quarter are almost of equal importance to the profession as information on the research into foot-and-mouth disease or the investigations into fowl plague, and the practitioner should ensure that he is well informed on both subjects.

Veterinary surgeons read the "farming" papers so that they can keep abreast of modern agricultural methods and progress; the perusal of the "Meat Trades Journal," a weekly periodical, will keep them informed on many topics of equal importance.

NEWS

TENTH WORLD'S POULTRY CONGRESS, 1954

THE Tenth World's Poultry Congress will be held in Edinburgh from August 13 to 21, 1954, under the auspices of the World's Poultry Science Association. The Congress is being organised by the Department of Agriculture for Scotland. Full details about the Congress, including membership fees, will be available shortly and will be mailed direct on request to the Congress Secretariat.

The activities of the Congress will include a programme of papers and discussions on every phase of the poultry industry and the National Committee of the World's Poultry Science Association will receive papers from authors.

The Congress organisation, therefore, desire to announce the regulations for the presentation of papers. The headings of the sections at the Paper Reading Sessions will be:—

(*a*) Genetics and breeding;

(*b*) Physiology and nutrition;

(*c*) Diseases and their control;

(*d*) Economics and marketing;

(*e*) Husbandry and miscellaneous.

The National Committee in each country will receive papers and decide whether or not to accept them for submission to the Congress organisation. National Committees have been advised to appoint sub-committees from experts in the several fields to examine all papers before they are allowed to go forward for acceptance. Authors from countries which do not have a National Committee should submit their application to present a paper together with copies of the paper direct to the Congress organisation.

Titles of papers proposed to be submitted should be sent to the Congress Secretariat before October 31, 1953, and *all papers must, without fail, be in the hands of the Congress Secretariat by January* 1, 1954. The address is: *St. Andrew's House, Edinburgh,* 1.

It will be open for any person to submit a paper to be read at the Congress whether or not he is a member of the World's Poultry Science Association.

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IMPROVED BRAXY VACCINE

Burroughs Wellcome & Co. announce the introduction of a new, improved Braxy Vaccine developed as a result of research in The Wellcome Research Laboratories. It contains the products of lysed *Cl. septicum* and the specific toxoid, the latter precipitated with potash alum. Field trials involving over 8,000 sheep have it is stated demonstrated the high level of efficiency of this new vaccine at a dose rate of 2 c.c. compared with 5 c.c. of the formalised whole culture vaccine which has been widely used during the past twenty years.

"Wellcome" Improved Braxy Vaccine is issued in containers of 50 c.c. (25 doses) and 100 c.c. (50 doses). Further information is obtainable on request to The Veterinary Sales Division, 183, Euston Road, London, N.W.1.

PRICE REDUCTION

GLAXO LABORATORIES, LTD., Greenford, Middlesex, announce that from Monday, July 6, the following reduced prices apply to Veterinary Cytamen:—

	Face price	*Trade price per doz.*
Vials "100" micrograms 10 c.c. ...	9/–	81/–
Ampoules "20" micrograms 6 x 1 c.c. ...	3/6	31/6

NOTICE

ALLEN & HANBURYS, LTD., announce the introduction of Dapsetyn, an intramammary injection for the treatment of acute mastitis, particularly summer mastitis in bovines.

Dapsetyn is supplied in boxes of 12 tubes of 8 g., each tube containing Alficetyn Brand of chloramphenicol B.P. 0.15 g. and Dapsone 0.3 g.

Publishers' Notices

THE BRITISH VETERINARY JOURNAL, with which is incorporated THE VETERINARY JOURNAL, is published monthly, and copy for advertisements should be in the hands of the advertisement manager not later than the 20th of the preceding month, if proof is required. Tel.: Temple Bar 3386.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

Annual Subscription 40s. ($6.50 U.S.A. currency, post free).